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for

TITLE: A SYSTEM AND METHOD FOR REMOTELY CONTROLLING AND MONITORING A PLURALITY OF COMPUTER SYSTEMS

TITLE OF INVENTION

A system and method for remotely controlling and monitoring a plurality of computer systems.

CROSS-REFERENCE TO RELATED APPLICATIONS

Not applicable.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

Not applicable.

REFERENCE TO MICROFICHE APPENDIX

Not applicable.

BACKGROUND OF THE INVENTION - FIELD OF INVENTION

This invention relates to the control and monitoring of computers, specifically to an improved Keyboard-Video-Mouse switch fully integrated with a video display, character input device, and pointing device.

BACKGROUND OF THE INVENTION - DISCUSSION OF PRIOR ART

Many computers capable of performing general purpose and specialized tasks require a computer room with raised flooring and air conditioning. Because computer room space is quite expensive, such computers must be mounted in a rack. Having a separate video display, character input device, and pointing device for each computer is impractical and wastes valuable computer room space. Keyboard-Video-Mouse (KVM) switches were developed which allows a single video display, character input device, and pointing device to communicate with one or more rack-mounted computers. However, requiring a separate video display, a separate character input device, a separate pointing device, and a separate KVM switch has the disadvantages of:

(a) consuming valuable rack space
(b) requiring a separate connector for video display, character input, and pointing data and signals on the KVM switch
(c) likelihood of malfunction due to a loose connection or failure of the aforementioned connectors and cables

(d) requiring the user to slide a video display monitor separately from a keyboard and pointing device from the rack before using the video display monitor and the keyboard and pointing device.

U.S. patents 5,721,842 (1998) and 5,884,096 (1999) and 5,937,176 (1999) to Beasley, et. al. (1998) merely specify a switching system but no display, character input device, or pointing device. Video signals are sent on cables separate from the keyboard and mouse signals. Furthermore, separate connectors are required on the switch side and on the remote computer side of cables used for video display, keyboard, and mouse. The programmable switch described as part of the claims uses only a single processor.

U.S. patent 5,732,212 to Perholtz, et. al. (1998) provides for a method of redirecting video display, keyboard, and mouse signals to a switch via a serial or parallel port or over a modem or network device on the computer being monitored or controlled. However, said method requires the use of special software or hardware which must be installed on the computer being monitored or controlled.

U.S. Patent 5,499,377 to Lee (1996) describes a multi-computer access switching system. Although sixteen (16) computers may be accessed from a work center the system requires a cable bus and a manual switch rather than an electronically controlled switch which may be controlled by a command entered from a keyboard.

U.S. Patent 5,949,643 to Batio (1999) describes a portable computer having split keyboard and pivotal display screen halves. Similarly, U.S. Patent 5,926,364 to Karidis (1999) describes a tri-fold personal computer with touchpad and keyboard. U.S. Patent 5,913,034 to Malcolm (1999) describes an administrator station for a computer system. However, such a device requires a notebook computer in order to function. In fact all of the described inventions and devices like them provide a display, keyboard, and pointing device but they are full fledged computers complete with CPU, memory, and secondary storage device and require an operating system in order to function. Such devices are relatively expensive and consume more power and space compared to a device which only has a display, keyboard, and pointing device.

Similarly, devices such as the device access controller in U.S. Patent 5,878,248 to Tehranian, et. al. (1999) also require a computer. Such devices also do not offer the convenience of easily multiplexing keyboard data, pointer data, and video signals from multiple computers.

The reference http://www.compaq.com/products/storageworks/options/1udrawerindex.html describes a keyboard drawer which consumes 1U (1.75 inches) of vertical rack space and the reference http://www.compaq.com/products/storageworks/options/skvm_index.html describes a KVM switch which may be mounted behind the 1U keyboard drawer but a video display device must be mounted separately in a rack.

ICS provides a flat panel display attached by a hinge to a drawer for a keyboard and pointing device. However, it consumes 2U (1.75 inches x 2) of vertical rack space.

Raritan offers a KVM switch, which offers one processor per channel or computer system. However, only one processor is active at a time and only when the channel associated with it is actively selected. Raritan KVM switches also offer a single connector for each computer system but the connector is wide and space consuming. The cascade mechanism used by Raritan does not utilize differential signaling for improved reliability.

Current KVM switches do not provide a means for upgrade, downloading or uploading of code, testing, or configuration of the KVM switch from a remote location. Furthermore, existing KVM switches do not have the capability of communicating with each other such that a plurality of interconnected KVM switches appear to the human user as a single KVM switch. The human user must be aware of which KVM switch a particular computer is connected in order to make use of the KVM switch. For example, the video output port, keyboard input port, and mouse input port of a first KVM switch must be connected into one of the video input ports, one of the keyboard output ports, and one of the mouse output ports of a second KVM switch. A human user must first select the video input port, keyboard output port, and mouse output port on the second KVM switch before the user is able to access the first KVM switch.

BRIEF SUMMARY OF THE INVENTION

In accordance with the present invention a intelligent control and monitoring system comprises at least one first processor communicating with a second processor, a video switch, video display, character input device, pointing device, and cable capable of carrying video signals, character input data, and pointing input data.

Objects and Advantages

Accordingly, several objects and advantages of the present invention are:

(a) To provide a compact control and monitoring system which minimizes the amount of rack space consumed by the following separate elements: KVM switch, video display, character input device, and pointing device;

(b) To provide a compact control and monitoring system which accepts data for video display and transmits data for character input and pointing to a computer but requires a single connector at the KVM switch;

(c) To provide a compact control and monitoring system which reduces the likelihood of a malfunction due to a loose connection or cable failure by reducing the number of cables and connections that must be made;

(d) To provide a compact control and monitoring system which extends out of a rack as a single unit;

Further objects and advantages are:

(a) To provide a control and monitoring system which allows upgrades, downloading or uploading of code, testing, and configuration from a remote location;

(b) To provide a control and monitoring system which can communicate with other control and monitoring systems;

(c) To provide a plurality of interconnected control and monitoring systems which appear to be a single control and monitoring system to a human user;

(d) To provide a control and monitoring system which has the ability to switch off power to the video display after a period of time has elapsed, where said period of time has been specified by a human user;

(e) To provide a control and monitoring system which utilizes a plurality of processing units, thereby reducing the likelihood of losing data from one of the computers connected to the compact control and monitoring system;

(f) To provide a control and monitoring system where a video display, a character input device, and a pointing device are protected from dust and impact from objects when the control and monitoring system is stored in a rack;

(g) To provide a control and monitoring system where no special software or hardware is required on the computer being monitored or controlled.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

Fig. 1 shows a rear view of the main unit.

Fig. 2 shows front view of the main unit.

Fig. 3 shows a rear view as installed in a rack.

Fig. 4 shows a front view as installed in a rack.

Fig. 5 shows a cable used to connect a computer system to the control and monitoring system.

Fig. 6 shows the connectors used on the cable used to connect a computer system to the control and monitoring system.

Figs. 7 and 8 show a block diagram of the control and monitoring system.

Fig. 9 shows a cable used to daisy chain multiple control and monitoring systems together.

Fig. 10 shows the connectors used on the cable in Fig. 9.

Fig. 11 shows a schematic view of a terminator used on the open end of the last cable used in a daisy chain of multiple control and monitoring systems.

Fig. 12A shows a rear view of the terminator in Fig. 11.

Fig. 12B shows a front view of the terminator in Fig. 11.

Reference Numerals In Drawings

8	Housing
10	External Video Out - fifteen position D-sub
12	Communications Port
14	External Keyboard Port - Mini-DIN
16	External Mouse Port - Mini-DIN
20	Keyboard-Video-Mouse Port 1 - fifteen position D-sub
22	Keyboard-Video-Mouse Port 2 - fifteen position D-sub
24	Keyboard-Video-Mouse Port 3 - fifteen position D-sub
26	Keyboard-Video-Mouse Port 4 - fifteen position D-sub
28	Keyboard-Video-Mouse Port 5 - fifteen position D-sub
30	Keyboard-Video-Mouse Port 6 - fifteen position D-sub
32	Keyboard-Video-Mouse Port 7 - fifteen position D-sub
34	Keyboard-Video-Mouse Port 8 - fifteen position D-sub

36 Keyboard-Video-Mouse Port 9 - fifteen position D-sub
38 Keyboard-Video-Mouse Port 10 - fifteen position D-sub
40 Keyboard-Video-Mouse Port 11 - fifteen position D-sub
42 Keyboard-Video-Mouse Port 12 - fifteen position D-sub
44 Keyboard-Video-Mouse Port 13 - fifteen position D-sub
46 Keyboard-Video-Mouse Port 14 - fifteen position D-sub
48 Keyboard-Video-Mouse Port 15 - fifteen position D-sub
50 Keyboard-Video-Mouse Port 16 - fifteen position D-sub
54 Internal Video Port - fifteen position D-sub
56 Internal Keyboard Port - Mini-DIN
58 Internal Mouse Port - Mini-DIN
60 DC Power Out to display, mouse, and keyboard
62 DC Power In
64 Power Supply AC Adapter receptacle
66 AC Power Supply
68 Video display
69 Housing for video display
70 Keyboard and touchpad housing
72 Keyboard
74 Touchpad
80 DC Power Cable
82 Cable stress relief arm
84 DC Power Cable
86 Mouse Cable
88 Keyboard Cable
90 Video Cable
92 Rail
94 Rail
100 Keyboard-Video-Mouse (KVM) Cable
102 KVM Connector - Male fifteen position D-sub
104 Video Connector - Male fifteen position D-sub
106 Keyboard Connector - Male Mini-DIN
108 Mouse Connector - Male Mini-DIN
121 KVM Connector Position 1 - Red Video
122 KVM Connector Position 2 - Green Video
123 KVM Connector Position 3 - Blue Video

124 KVM Connector Position 4 - Keyboard Power
125 KVM Connector Position 5 - Keyboard Clock
126 KVM Connector Position 6 - Video Ground
127 KVM Connector Position 7 - Video Ground
128 KVM Connector Position 8 - Video Ground
129 KVM Connector Position 9 - Mouse Power
130 KVM Connector Position 10 - Keyboard Data
131 KVM Connector Position 11 - Mouse Clock
132 KVM Connector Position 12 - Mouse Data
133 KVM Connector Position 13 - Horizontal Sync
134 KVM Connector Position 14 - Vertical Sync
135 KVM Connector Position 15 - Keyboard and Mouse Ground
141 Video Connector Position 1 - Red Video
142 Video Connector Position 2 - Green Video
143 Video Connector Position 3 - Blue Video
144 Video Connector Position 4 - ID BIT 2
145 Video Connector Position 5 - DDC Signal Return
146 Video Connector Position 6 - Red Video Signal Return
147 Video Connector Position 7 - Green Video Signal Return
148 Video Connector Position 8 - Blue Video Signal Return
149 Video Connector Position 9 - Power Line for DDC
150 Video Connector Position 10 - SYNC Signal Return
151 Video Connector Position 11 - ID Bit 11 (Reserved)
152 Video Connector Position 12 - Data Line for DDC
153 Video Connector Position 13 - Horizontal Sync
154 Video Connector Position 14 - Vertical Sync
155 Clock Line for DDC
161 KB Connector Position 1 - Keyboard Data
162 KB Connector Position 2 - No Connection
163 KB Connector Position 3 - Signal Ground
164 KB Connector Position 4 - +5V Supply
165 KB Connector Position 5 - KB Clock
166 KB Connector Position 6 - No Connection
171 Mouse Connector Position 1 - Mouse Data
172 Mouse Connector Position 2 - No Connection
173 Mouse Connector Position 3 - Signal Ground

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174 Mouse Connector Position 4 - +5 Supply

175 Mouse Connector Position 5 - Mouse Clock

176 Mouse Connector Position 6 - No Connection

200 Keyboard and Mouse signals to KVM port 20

202 Keyboard and Mouse signals to KVM port 22

204 Keyboard and Mouse signals to KVM port 24

206 Keyboard and Mouse signals to KVM port 26

208 Keyboard and Mouse signals to KVM port 28

210 Keyboard and Mouse signals to KVM port 30

212 Keyboard and Mouse signals to KVM port 32

214 Keyboard and Mouse signals to KVM port 34

216 Keyboard and Mouse signals to KVM port 36

218 Keyboard and Mouse signals to KVM port 38

220 Keyboard and Mouse signals to KVM port 40

222 Keyboard and Mouse signals to KVM port 42

224 Keyboard and Mouse signals to KVM port 44

226 Keyboard and Mouse signals to KVM port 46

228 Keyboard and Mouse signals to KVM port 48

230 Keyboard and Mouse signals to KVM port 50

232 Processor

234 Processor

236 Processor

238 Processor

240 Processor

242 Processor

244 Processor

246 Processor

248 Clock generator for processor 232

250 Clock signal

252 Clock generator for processor 234

254 Clock signal

256 Clock generator for processor 236

258 Clock signal

260 Clock generator for processor 238

262 Clock signal

264 Clock generator for processor 240

266	Clock signal
268	Clock generator for processor 242
270	Clock signal
272	Clock generator for processor 244
274	Clock signal
276	Clock generator for processor 246
278	Clock signal
280	Keyboard and Mouse signals from processor 232
282	Keyboard and Mouse signals from processor 234
284	Keyboard and Mouse signals from processor 236
286	Keyboard and Mouse signals from processor 238
288	Keyboard and Mouse signals from processor 240
290	Keyboard and Mouse signals from processor 242
292	Keyboard and Mouse signals from processor 244
294	Keyboard and Mouse signals from processor 246
296	Processor
298	Programmable Logic
300	Control
302	Non-volatile Random Access Memory (NVRAM)
304	Control
306	Data
308	Flash memory
310	Data
312	Clock generator
314	Clock signal
316	Keyboard signals
318	Mouse signals
320	Data
322	Video Select
324	Video Switch
326	Red, Green, Blue, Horizontal sync, and Vertical sync video signals from KVM Port 20
328	Red, Green, Blue, Horizontal sync, and Vertical sync video signals from KVM Port 22
330	Red, Green, Blue, Horizontal sync, and Vertical sync video signals from KVM Port 24

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332 Red, Green, Blue, Horizontal sync, and Vertical sync video signals from KVM Port 26

334 Red, Green, Blue, Horizontal sync, and Vertical sync video signals from KVM Port 28

336 Red, Green, Blue, Horizontal sync, and Vertical sync video signals from KVM Port 30

338 Red, Green, Blue, Horizontal sync, and Vertical sync video signals from KVM Port 32

340 Red, Green, Blue, Horizontal sync, and Vertical sync video signals from KVM Port 34

342 Red, Green, Blue, Horizontal sync, and Vertical sync video signals from KVM Port 36

344 Red, Green, Blue, Horizontal sync, and Vertical sync video signals from KVM Port 38

346 Red, Green, Blue, Horizontal sync, and Vertical sync video signals from KVM Port 40

348 Red, Green, Blue, Horizontal sync, and Vertical sync video signals from KVM Port 42

350 Red, Green, Blue, Horizontal sync, and Vertical sync video signals from KVM Port 44

352 Red, Green, Blue, Horizontal sync, and Vertical sync video signals from KVM Port 46

354 Red, Green, Blue, Horizontal sync, and Vertical sync video signals from KVM Port 48

356 Red, Green, Blue, Horizontal sync, and Vertical sync video signals from KVM Port 50

358 Horizontal sync

360 Vertical sync

362 Red, Green, and Blue video signals

364 Programmable Logic

366 Data

367 Horizontal Sync and Vertical sync

368 Data

370 Processor

372 Clock generator

374 Clock signal

376 EIA-RS-232 Transmitter/Receiver
378 EIA-RS-485 Transceiver
380 EIA-RS-485 Transceiver
382 EIA-RS-485 Transceiver
384 Transmit Data (TX)
386 Receive Data (RX)
388 Transmit Data (TX)
390 Receive Data (RX)
392 Differential Transmit/Receive High(Tx+)
396 Differential Transmit/Receive Low(Tx-)
398 Single-ended Transmit/Receive
400 Differential Receive/Transmit High(Rx+)
404 Differential Receive/Transmit Low(Rx-)
406 Single-ended Receive/Transmit
408 Differential Clock Out/In High (Clock+)
412 Differential Clock In/Out Low (Clock-)
414 Single-ended Clock In/Out
420 Video Driver
422 Red, Green, Blue, Horizontal sync, Vertical sync
424 Red, Green, Blue, Horizontal sync, Vertical sync
440 Daisy Chain cable
442 Connector for Communications Port and Daisy Chain
444 Connector for Communications Port and Daisy Chain
446 Connector for Communications Port and Termination
448 Connector for Communications Port and Termination
450 Connector for Communications Port and Daisy Chain position 1 - EIA-RS-485 Tx+
452 Connector for Communications Port and Daisy Chain position 2 - EIA-RS-232 TxD
454 Connector for Communications Port and Daisy Chain position 3 - EIA-RS-232 RxD
456 Connector for Communications Port and Daisy Chain position 4 - EIA-RS-485 Rx-
458 Connector for Communications Port and Daisy Chain position 5 - Ground
460 Connector for Communications Port and Daisy Chain position 6 -

EIA-RS-485 Tx-

462 Connector for Communications Port and Daisy Chain position 7 - EIA-RS-485 Clock-

464 Connector for Communications Port and Daisy Chain position 8 - EIA-RS-485 Clock+

466 Connector for Communications Port and Daisy Chain position 9 - EIA-RS-485 Rx+

468 Connector for Communications Port and Termination position 1 - EIA-RS-485 Tx+

470 Connector for Communications Port and Termination position 2 - EIA-RS-232 TxD

472 Connector for Communications Port and Termination position 3 - EIA-RS-232 RxD

474 Connector for Communications Port and Termination position 4 - EIA-RS-485 Rx-

476 Connector for Communications Port and Termination position 5 - Ground

478 Connector for Communications Port and Termination position 6 - EIA-RS-485 Tx-

480 Connector for Communications Port and Termination position 7 - EIA-RS-485 Clock-

482 Connector for Communications Port and Termination position 8 - EIA-RS-485 Clock+

484 Connector for Communications Port and Termination position 9 - EIA-RS-485 Rx+

486 Connector for Communications Port and Daisy Chain position 1 - EIA-RS-485 Tx+

488 Connector for Communications Port and Daisy Chain position 2 - EIA-RS-232 TxD

490 Connector for Communications Port and Daisy Chain position 3 - EIA-RS-232 RxD

492 Connector for Communications Port and Daisy Chain position 4 - EIA-RS-485 Rx-

494 Connector for Communications Port and Daisy Chain position 5 - Ground

496 Connector for Communications Port and Daisy Chain position 6 - EIA-RS-485 Tx-

498 Connector for Communications Port and Daisy Chain position 7 - EIA-RS-485 Clock-

500 Connector for Communications Port and Daisy Chain position 8 - EIA-RS-485 Clock+

502 Connector for Communications Port and Daisy Chain position 9 - EIA-RS-485 Rx+

504 Connector for Communications Port and Termination position 1 - EIA-RS-485 Tx+

506 Connector for Communications Port and Termination position 2 - EIA-RS-232 TxD

508 Connector for Communications Port and Termination position 3 - EIA-RS-232 RxD

510 Connector for Communications Port and Termination position 4 - EIA-RS-485 Rx-

512 Connector for Communications Port and Termination position 5 - Ground

514 Connector for Communications Port and Termination position 6 - EIA-RS-485 Tx-

516 Connector for Communications Port and Termination position 7 - EIA-RS-485 Clock-

518 Connector for Communications Port and Termination position 8 - EIA-RS-485 Clock+

520 Connector for Communications Port and Termination position 9 - EIA-RS-485 Rx+

610 Terminator for Daisy Chain

612 Resistor

614 Resistor

616 Resistor

620 Terminator Position 1

626 Terminator Position 4

630 Terminator Position 6

632 Terminator Position 7

634 Terminator Position 8

636 Terminator Position 9

DETAILED DESCRIPTION OF THE INVENTION

Preferred Embodiment - Figs. 1, 2, 3, and 4

A preferred embodiment of the control and monitoring system of the present invention is illustrated in FIG. 1 (rear view). In the presently preferred embodiment of the control and monitoring system, up to sixteen (16) computer systems may be controlled and monitored from a single control and monitoring system and up to two hundred fifty six (256) if a plurality of control and monitoring systems are connected together. However, those skilled in the art will recognize that the number of possible connections may be modified to accommodate an unlimited number of computer systems.

A main unit housing **8** provides a mounting base for the Mini-DIN, DB9, and fifteen position D-sub connectors. An external video display device compatible with the VGA standard may be connected to an External Video Port **10**. An External keyboard may be connected to an External Keyboard Port **14**. An external mouse or other pointing device may be connected to an External Mouse Port **16**. A computer or communications device capable of communicating with a computer may be connected via a standard IBM-type DB9 serial cable to the Communications Port **12**. A computer system may be connected to any of Keyboard-Video-Mouse (KVM) Ports 1-16 (**20,22,24,26,28,30,32,34,36,38,40,42,44,46,48,50**).

Fig. 2 details the present front view of the main unit **8** of the control and monitoring system. Power is supplied to the control and monitoring system through a power connector **62**. Power to a video display **68** (Fig. 4), a keyboard **72**, and a touchpad **74** (Fig. 3) is sent out through a power connector **60**. The video display **68** is connected to an internal video port **54**. The keyboard **72** is connected to an internal keyboard port **56**. The touchpad **74** is connected to an internal mouse port **58**.

Fig. 3 details the present rear view of the control and monitoring system in the open position. A power supply **66** receives power when a power cord is plugged into AC power receptacle **64** and connecting the male end of the three-prong AC power cord into a source for AC power such as a public utility wall outlet or a battery backup system. The

control and monitoring system receives power from a power supply cable **80** connected to a power connector **60**. A first housing **69** houses a display **68**. A second housing **70** houses a combined keyboard and pointing device comprising a keyboard **72**, and a touchpad **74**. The first housing and second housing are rotatably connected such that the display may be stored against the keyboard and pointing device and flipped out when needed. The first housing and second housing so connected are referred to as the administration station. The second housing may have a cowling or cover in a shape complementary to the shape of the power supply **66** and the main unit housing **8** such that any cables running between the administration station and the main unit housing **8** are covered when the administration station is stored. A power cable **84** supplies power from the main unit housing **8** through a power connector **60** to a display **68**, a keyboard **72**, and a pointing device **74**. A keyboard cable **86** connects the internal keyboard port **56** to the keyboard **72**. A mouse cable **88** connects the internal mouse port **58** to the touchpad **74**. A video cable **90** connects the internal video port **54** to the video display **68**. A cable tray arm **82** relieves stress on the cables, organizes the cables neatly and prevents them from tangling. The main unit **8** is connected to the power supply **66** and attached to a rail **92** and a rail **94**. The cable tray arm **82** is attached to the rail **94**. The keyboard **72**, touchpad **74**, and display **68** are mounted on a rail **92** and a rail **94** and may slide forward and backward along the rails. The display **68** rotates up and down via two hinges or other rotation mechanism.

Fig. 4 details the present front view of the control and monitoring system in an open position. The control and monitoring system may be mounted in a standard nineteen-inch wide rack but may also be used without the benefit of a rack. The preferred embodiment of the present invention consumes not more than 1U (1.75 inches) of vertical space while the keyboard **72**, touchpad **74**, and display **68** are in the stored position. Of course, the control and monitoring system may consume more or less vertical space while maintaining a compact profile.

Fig. 5 details a cable used to connect a computer system to any of the KVM Ports 1-16. The fifteen position D-sub connector **102** connects to any of the KVM Ports 1-16 (**20,22,24,26,28,30,32,34,36,38,40,**

42,44,46,48,50). The fifteen position D-sub connector **104** connects to the graphics adapter of the remote computer. The mini-DIN connector **106** connects to the keyboard port of the remote computer. The mini-DIN connector **108** connects to the mouse port of the remote computer.

Fig. 6 details a head on view of the connectors shown in fig. 5. The positions are connected in the following manner:

Keyboard-Video-Mouse (KVM) Male fifteen position D-sub Connector **102** Position	Connection Description	Position Connection
KVM Connector Position **121**	Red Video	Video Connector Position **141**
KVM Connector Position **122**	Green Video	Video Connector Position **142**
KVM Connector Position **123**	Blue Video	Video Connector Position **143**
KVM Connector Position **124**	Keyboard Power	Keyboard Connector Position **164**
KVM Connector Position **125**	Keyboard Clock	Keyboard Connector Position **165**
KVM Connector Position **126**	Red Video Signal Return	Video Connector Position **146**
KVM Connector Position **127**	Green Video Signal Return	Video Connector Position **147**
KVM Connector Position **128**	Blue Video Signal Return	Video Connector Position **148**
KVM Connector Position **129**	Mouse Power	Mouse Connector Position **174**
KVM Connector Position **130**	Keyboard Data	Keyboard Connector Position **161**
KVM Connector Position **131**	Mouse Clock	Mouse Connector Position **175**

KVM Connector Position **132**	Mouse Data	Mouse Connector Position **171**
KVM Connector Position **133**	Horizontal Sync	Video Connector Position **153**
KVM Connector Position **134**	Vertical Sync	Video Connector Position **154**
KVM Connector Position **135**	Keyboard and Mouse Ground	Keyboard Connector Position **163** and Mouse Connector Position **173**

Additionally, the cable shield runs along the portion of the KVM cable **100** extending from the Keyboard-Video-Mouse Male fifteen position D-sub Connector **102** side to the Video Male fifteen position D-sub Connector **104** side.

Figs. 7 and 8 depict a block diagram of the control and monitoring system. Two Keyboard-Video-Mouse (KVM) ports (**20,22,24,26,28,30,32,34, 36,38,40,42,44,46,48,50**) connect to a processor **232**, **234**, **236**, **238**, **240**, **242**, **244**, or **246**. Each of the processors controls two KVM ports. All eight processors **232, 234, 236, 238, 240, 242, 244,** and **246** connect to a processor **296**. Processor **296** connects to a video switch **324** and a processor **320**.

Keyboard and mouse signals **200** are sent and received between a KVM port **48** and a processor **232**.

Keyboard and mouse signals **202** are sent and received between a KVM port **50** and a processor **232**.

Keyboard and mouse signals **204** are sent and received between a KVM port **44** and a processor **234**.

Keyboard and mouse signals **206** are sent and received between a KVM port **46** and a processor **234**.

Keyboard and mouse signals **208** are sent and received between a KVM port **40** and a processor **236**.

Keyboard and mouse signals **210** are sent and received between a KVM port **42** and a processor **236**.

Keyboard and mouse signals **212** are sent and received between a KVM port **36** and a processor **238**.

Keyboard and mouse signals **214** are sent and received between a KVM port **38** and a processor **238**.

Keyboard and mouse signals **216** are sent and received between a KVM port **32** and a processor **240**.

Keyboard and mouse signals **218** are sent and received between a KVM port **34** and a processor **240**.

Keyboard and mouse signals **220** are sent and received between a KVM port **28** and a processor **242**.

Keyboard and mouse signals **222** are sent and received between a KVM port **30** and a processor **242**.

Keyboard and mouse signals **224** are sent and received between a KVM port **24** and a processor **244**.

Keyboard and mouse signals **226** are sent and received between a KVM port **26** and a processor **244**.

Keyboard and mouse signals **228** are sent and received between a KVM port **20** and a processor **246**.

Keyboard and mouse signals **230** are sent and received between a KVM port **22** and a processor **246**.

A clock generator **248** provides a clock signal **250** to processor **232**.

A clock generator **252** provides a clock signal **254** to processor **234**.

A clock generator **256** provides a clock signal **258** to processor **236**.

A clock generator **260** provides a clock signal **262** to processor **238**.

A clock generator **264** provides a clock signal **266** to processor **240**.

A clock generator **268** provides a clock signal **270** to processor **242**.

A clock generator **272** provides a clock signal **274** to processor **244**.

A clock generator **276** provides a clock signal **278** to processor **246**.

A processor **296** is connected to processors **232, 234, 236, 238, 240, 242, 244,** and **246**. A clock generator **312** provides a clock signal **314** to processor **296**. Data signals **310** travel between a flash memory **308** and a processor **296**. Data signals **300** travel between a programmable logic device and processor **296**. Data signals **306** travel between a Non-volatile Random Access Memory (NVRAM) **302** and a processor **296**. Control signals **304** travel between a NVRAM **302** and a programmable logic device **298**.

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Processors **232, 234, 236, 238, 240, 242, 244,** and **246** are referred to as Port Controllers.

Keyboard signals **316** travels between a processor **296** and keyboard ports **14** and **56**. Mouse signals **318** travel between a processor **296** and mouse ports **16** and **58**.

Fig. 8 shows a video switch **324**. A processor **296** asserts a video select signal **322** to a video switch **324**. Processor **296** is referred to as the Main Controller.

Red, Green, Blue, Vertical Sync, and Horizontal Sync video signals **326** pass from KVM port **20** to video switch **324**.

Red, Green, Blue, Vertical Sync, and Horizontal Sync video signals **328** pass from KVM port **22** to video switch **324**.

Red, Green, Blue, Vertical Sync, and Horizontal Sync video signals **330** pass from KVM port **24** to video switch **324**.

Red, Green, Blue, Vertical Sync, and Horizontal Sync video signals **332** pass from KVM port **26** to video switch **324**.

Red, Green, Blue, Vertical Sync, and Horizontal Sync video signals **334** pass from KVM port **28** to video switch **324**.

Red, Green, Blue, Vertical Sync, and Horizontal Sync video signals **336** pass from KVM port **30** to video switch **324**.

Red, Green, Blue, Vertical Sync, and Horizontal Sync video signals **338** pass from KVM port **32** to video switch **324**.

Red, Green, Blue, Vertical Sync, and Horizontal Sync video signals **340** pass from KVM port **34** to video switch **324**.

Red, Green, Blue, Vertical Sync, and Horizontal Sync video signals **342** pass from KVM port **36** to video switch **324**.

Red, Green, Blue, Vertical Sync, and Horizontal Sync video signals **344** pass from KVM port **38** to video switch **324**.

Red, Green, Blue, Vertical Sync, and Horizontal Sync video signals **346** pass from KVM port **40** to video switch **324**.

Red, Green, Blue, Vertical Sync, and Horizontal Sync video signals **348** pass from KVM port **42** to video switch **324**.

Red, Green, Blue, Vertical Sync, and Horizontal Sync video signals **350** pass from KVM port **44** to video switch **324**.

Red, Green, Blue, Vertical Sync, and Horizontal Sync video signals **352** pass from KVM port **46** to video switch **324**.

Red, Green, Blue, Vertical Sync, and Horizontal Sync video signals **354** pass from KVM port **48** to video switch **324**.

Red, Green, Blue, Vertical Sync, and Horizontal Sync video signals **356** pass from KVM port **50** to video switch **324**.

Control **368** travels between a programmable logic device **364** and a processor **370**. Data **320** travels between a processor **296** and a processor **370**. A clock generator **372** provides a clock signal **374** to a processor **370**. Processor **370** is referred to as the Host Controller.

Transmit Data (TX) signals **384** travels from an EIA-RS-232 port **12** to an EIA-RS-232 Transmitter/Receiver **376**. Receive Data (RX) signals **386** travels from an EIA-RS-232 Transmitter/Receiver **376** to an EIA-RS-232 port **12**. TX data signals **386** travel from an EIA-RS-232 Transmitter/Receiver to a processor **370**. RX data signals **390** travel from a processor **370** to an EIA-RS-232 Transmitter/Receiver **376**.

A single-ended transmit/receive data signal **398** travels between a processor **370** and an EIA-RS-485 transceiver **378**. A differential transmit/receive data high signal **392** travels between the EIA-RS-485 transceiver **378** and the communications port **12**. A differential transmit/receive data low signal **396** travels between the EIA-RS-485 transceiver **378** and the communications port **12**.

A differential receive/transmit data high signal **400** travels between the communications port **12** and an EIA-RS-485 transceiver **380**. A single-ended receive/transmit data signal **406** travels between the EIA-RS-485 transceiver **380** and the processor **370**. A differential receive/transmit data low signal **404** travels between the communications port **12** and the EIA-RS-485 transceiver **380**.

A single-ended clock signal **414** passes between the processor **370** and an EIA-RS-485 transceiver **382**. A differential clock high signal **408** passes between the EIA-RS-485 transceiver **382** and the communications port **12**. A differential clock low signal **412** travels between the communications port **12** and the EIA-RS-485 transceiver **382**. A Horizontal Sync signal **358** passes from a video switch **324** to a programmable logic

device **364**. A Vertical Sync signal **360** passes from a video switch **324** to a programmable logic device **364**.

Horizontal Sync and Vertical Sync signals **367** pass from a programmable logic device **364** to a Video Driver **420**. On screen menu display data passes over data path **366** from a programmable logic device **364** to a Video Driver **420**.

Red, Green, and Blue video signals **362** pass from a video switch **324** to video driver **420**.

Video driver **420** takes the Red, Green, and Blue video signals **362**, and the Horizontal and Vertical Sync signals **367** and sends Red, Green, Blue, Horizontal Sync, and Vertical Sync signals **422** to video port **10** and Red, Green, Blue, Horizontal Sync, and Vertical Sync signals **424** are sent video port **54**.

Fig. 9 shows a daisy chain cable **440** used to daisy chain multiple control and monitoring systems together. A connector for the communications port and daisy chain **444** and a connector for the communications port and termination **446** comprises one end of the cable. A connector for the communications port and daisy chain **442** and a connector for the communications port and termination **448** comprise the other end of the cable.

Fig. 10 shows a position mapping for each of the connectors of the daisy chain cable **440**. The following tables show the mapping of the positions:

Position on connector for communications port and daisy chain **444**	Description	Position Connection
Position 1 **450**	EIA-RS-485 Tx+	Connector **446** Position 1 **468** and Connector **442** Position 1 **486**
Position 2 **452**	EIA-RS-232 TxD	Connector **446** Position 2 **470**
Position 3 **454**	EIA-RS-232 RxD	Connector **446** Position 3 **472**
Position 4 **456**	EIA-RS-485 Rx-	Connector **446** Position 4 **474** and Connector **442** Position 4 **492**
Position 5 **458**	Ground	Connector **446** Position 5 **476** and Connector **442** Position 5 **494**
Position 6 **460**	EIA-RS-485 Tx-	Connector **446** Position 6 **478** and Connector **442** Position 6 **496**
Position 7 **462**	EIA-RS-485 Clock-	Connector **446** Position 7 **480** and Connector **442** Position 7 **498**
Position 8 **464**	EIA-RS-485 Clock+	Connector **446** Position 8 **482** and Connector **442** Position 8 **500**
Position 9 **466**	EIA-RS-485 Rx+	Connector **446** Position 9 **484** and Connector **442** Position 9 **502**

Position on connector for communications port and daisy chain **442**	Description	Position Connection
Position 1 **486**	EIA-RS-485 Tx+	Connector **448** Position 1 **504** and Connector **444** Position 1 **450**
Position 2 **488**	EIA-RS-232 TxD	Connector **448** Position 2 **506**
Position 3 **490**	EIA-RS-232 RxD	Connector **448** Position 3 **508**
Position 4 **492**	EIA-RS-485 Rx-	Connector **448** Position 4 **510** and Connector **444** Position 4 **456**
Position 5 **494**	Ground	Connector **448** Position 5 **512** and Connector **444** Position 5 **458**
Position 6 **496**	EIA-RS-485 Tx-	Connector **448** Position 6 **514** and Connector **444** Position 6 **460**
Position 7 **498**	EIA-RS-485 Clock-	Connector **448** Position 7 **516** and Connector **444** Position 7 **462**
Position 8 **500**	EIA-RS-485 Clock+	Connector **448** Position 8 **518** and Connector **444** Position 8 **464**
Position 9 **502**	EIA-RS-485 Rx+	Connector **448** Position 9 **520** and Connector **444** Position 9 **466**

Fig. 11 shows a schematic view of a terminator **610** used on the open end of the first and last cables in a daisy chain of multiple control and monitoring systems. A resistor **612** is connected to terminator position 1 **620** and terminator position 6 **630** such that when the terminator **610** is connected to communications port and termination connector **446**, communications port and daisy chain connector **444** position 1 **450** and communications port and daisy chain connector **444** position 6 **460** are terminated. A resistor **614** is connected to terminator position 4 **626** and terminator position 9 **636** such that when terminator **610** is connected to communications port and termination connector **446**, communications port and daisy chain connector **444** position 4 **456** and

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communications port and daisy chain connector **444** position 9 **466** are terminated. A resistor **616** is connected to terminator position 7 **632** and terminator position 9 **634** such that when terminator **610** is connected to communications port and termination connector **446**, communications port and daisy chain connector **444** position 7 **462** and communications port and daisy chain connector **444** position 8 **464** are terminated.

Fig. 12A shows a rear view of the terminator and Fig. 12B shows a front view of the terminator. All positions on the front connector of the terminator are connected to each respective position on the rear connector of the terminator in a straight through fashion.

In the preferred embodiment, processors **232, 234, 236, 238, 240, 242, 244, 246, 296,** and **370** are Atmel Corporation model AT89S8252 microcontrollers or equivalent; programmable logic devices **298** and **364** are Xilinx Corporation model XC9536 Complex Programmable Logic Devices (CPLDs) or equivalent; flash memory **308** is Atmel Corporation model AT29C020 or equivalent; NVRAM **302** is Dallas Semiconductor model DS1230AB-70 or equivalent; EIA-RS-232 Transmitter/Receiver **376** is Dallas Semiconductor model DS232 or equivalent;EIA-RS-485 Transceiver **378, 380,** and **382** are Maxim Integrated Products model MAX485 or equivalent.

a
a

A ~~floppy disk~~ Compact disc comprising object code for the programmable logic and the microcontrollers is attached. The contents of the compact disc should be copied to a floppy disk. The following equipment should be used when programming the programmable logic and the microcontrollers:

1) Laptop or PC running Windows (NT, Win95 or Win98) Operating System.
2) Equinox Activ8r Programmer connected to the Laptop or PC's serial port via a serial straight-thru EIA-RS-232 DB9 female to DB9 male cable.
3) A 10 conductor flat ribbon cable to perform in system programming (ISP).
4) Equinox Meridian Suite programming software installed in the laptop or PC.
5) Serial straight-thru EIA-RS-232 DB-9 female to DB-9 male cable to interconnect between the control and monitoring system and the Laptop or PC.

6) Xilinx Foundation F1.5 software installed in the laptop or PC, to use the JTAG programmer program jtagprog.exe.

7) Xilinx Parallel Cable III Model DLC5 that connects to the laptop or PC.

The following procedure should be used in order to program the Programmable Logic, Programmable Logic **298** and **364** should be connected to a 6 pin JTAG connector in order to enable In System Programming from a programming device:

1) Make sure the Xilinx Foundation F1.5's JTAG programmer is properly installed in the laptop or PC and that jtagprog.exe is in the execution path. Open an MSDOS Shell.

2) Connect the DB-25 end of the Xilinx DLC5 Parallel Cable III to the laptop or PC's parallel port.

3) Connect the 6 pin ribbon cable end of the Xilinx DLC5 Parallel Cable III to the Host Controller's Programmable Logic **364** to the 6 pin JTAG connector. Apply power to the control and monitoring system.

4) On the laptop or PC in the MSDOS shell, change directory to the floppy diskette source and execute "proghost". Wait for operations of erase, program and verification of the Host Controller's Programmable Logic **364** and finally for the command prompt.

5) Power down the control and monitoring system and move the 6 pin ribbon cable end of the Xilinx DLC5 Parallel Cable III from the Host Controller's Programmable Logic **364** JTAG header pins to the Main Controller's Programmable Logic **298** JTAG header pins. Apply power to the control and monitoring system.

6) On the laptop or PC in the MSDOS shell, change directory to the floppy diskette source and execute "progmain". Wait for operations of erase, program and verification of the Main Controller's Programmable Logic **298** and finally for the command prompt.

Power down the control and monitoring system and remove the 6 pin ribbon cable end of the Xilinx DLC5 Parallel Cable III from the Main Controller's Programmable Logic **298** JTAG header pins.

The following procedure should be used in order to program the Host Controller, processor **370** should be connected to a 10 pin ISP connector in order to enable In System Programming from a programming device:

1) Connect the Activ8r programmer to the Host Controller, processor **370** to the 10 pin ISP connector via the 10 conductor flat ribbon cable. Be sure to jumper the programmer to use its own external power source, instead of the target's. Apply power to the programmer unit and to the control and monitoring system.
2) Run Meridian programmer software and initialize the programmer hardware via the serial port for flashing the Host Controller, processor **370**. Load into the buffer the AdmCtrl.hex code from the floppy diskette source. Erase the Host Controller, processor **370** and then program it with the data from the program buffer.
3) Power down the control and monitoring system and remove the interconnecting ISP cable.

The following procedure should be used in order to program the Main Controller, processor **296** and Port Controllers, processors **232**,**234**,**236**, **238**,**240**,**242**,**244**, and **246**:

1) Power up the control and monitoring system. Connect the serial EIA-RS-232 cable between the DB9 serial port **12** and the Laptop or PC's serial port.
2) Insert the source diskette to Laptop or PC, run CPDnld and use it to communicate with the Host Controller, processor **370** via the DB9 serial port **12**.
3) Login with a predetermined password. The following password could be used: "System Administrator".

4) Download to the internal flash EPROM of the Main Controller, processor **296** with the OperDnld.hex code from the floppy diskette source.

(a) To the "?" prompt type "Ctrl]" which will invoke the command mode.

(b) To the "Cmd:" prompt type "d"

(c) To the "Enter filename:" prompt type "a:\OperDnld.hex"

(d) To the "Enter destination (D=OperInternal, E=Port, F= OperFlashEPROM or G=OperNVRAM)" prompt type "D".

(e) After completion of the download process, to the "Cmd:" prompt type "r" to return to terminal mode.

(f) Type Enter key to elicit a "?" prompt from the Administrator software.

5) Download to one of the internal flash EPROM of one of the Port Controllers, processors **232,234,236,238,240,242,244,246** with the PortCtrl.hex code from the floppy diskette source.

(a) To the "?" prompt type "Ctrl]" which will invoke the command mode.

(b) To the "Cmd:" prompt type "d"

(c) To the "Enter filename:" prompt type "a:\PortCtrl.hex"

(d) To the "Enter destination (D=OperInternal, E=Port, F= OperFlashEPROM or G=OperNVRAM)" prompt type "E".

(e) After completion of the download process, to the "Cmd:" prompt type "r" to return to terminal mode.

(f) Type Enter key to elicit a "?" prompt from the Administrator software.

6) Download to the Operation processor's external flash EPROM with the OperCtrl.hex code from the floppy diskette source.

(a) To the "?" prompt type "I" to switch to internal Operation code memory.

(b) To the "?" prompt type "Ctrl]" which will invoke the command mode.

(c) To the "Cmd:" prompt type "d"

(d) To the "Enter filename:" prompt type "a:\OperCtrl.hex"

(e) To the "Enter destination (D=OperInternal, E=Port, F= OperFlashEPROM or G=OperNVRAM)" prompt type "F".

(f) After completion of the download process, to the "Cmd:" prompt type "r" to return to terminal mode.

(g) Type Enter key to elicit a "?" prompt from the Administrator software.

7) Download to the Operation processor's NVRAM with the DefNVRAM.hex code from the floppy diskette source.

(h) To the "?" prompt type "I" to switch to internal Operation code memory.

(i) To the "?" prompt type "Ctrl]" which will invoke the command mode.

(j) To the "Cmd:" prompt type "d"

(k) To the "Enter filename:" prompt type "a:\DefNVRAM.hex"

(l) To the "Enter destination (D=OperInternal, E=Port, F=OperFlashEPROM or G=OperNVRAM)" prompt type "G".

(m) After completion of the download process, to the "Cmd:" prompt type "r" to return to terminal mode.

(n) Type Enter key to elicit a "?" prompt from the Administrator software.

7) Reset the control and monitoring system by powering down and then waiting for a few seconds before powering up and the unit should be ready to operate for its designed function.

Operation of Invention

Each computer to be controlled and monitored is connected to the control and monitoring system via a Keyboard-Video-Mouse (KVM) Cable **100**. A keyboard connector **106** plugs into the keyboard port of the computer to be controlled and monitored. A mouse connector **108** plugs into the mouse port of the computer to be controlled and monitored. A video connector **104** plugs into the video port of the computer to be controlled and monitored. A KVM connector **102** plugs into one of the KVM ports **20**, **22**, **24**, **26**, **28**, **30**, **32**, **34**, **36**, **38**, **40**, **42**, **44**, **46**, **48**, **50**.

The processor **296** communicates with the processor **370** via the data path **320**. The processor **370** can also communicate with a computer

attached to the communications port **12** via a modem cable or via a null modem cable and a modem. The processor **370**, also known as the Host Controller, also looks for EIA-RS-232 Receive Data signals **386** coming from the EIA-RS-232 Transmitter/Receiver **376** and passes the Receive Data signal **390** to the processor **370**. The processor **370** can send acknowledgements or other data via EIA-RS-232 Transmit Data signal **386** to the EIA-RS-232 Transmitter/Receiver 376 which then passes EIA-RS-232 Transmit Data signals **384**.

The computer attached to communications port **12** may transmit any of several commands, including but not limited to:

- Print the available commands menu
- Login and establish an administration (admin) session
- Logout from admin session
- Reset the entire system
- Read current configuration settings
- Set configuration settings
- Switch operating software between internal flash memory on the processor **296** and flash memory **308**.
- Perform diagnostic tests
- Set local options
    - Select the Port Controllers that will be active in subsequent operations of erase, program, and upload.
- Switch the execution of processor **296** (also known as the Main Controller) between internal flash memory and flash memory **308**
- Erase internal flash memory on the processor **296**, flash memory **308**, or any or all of the Port Controllers' flash memory.
- Download code and data and program internal flash memory on the processor **292**, flash memory **308**, or for any or all of the Port Controllers' flash memory.
- Download code and data to NVRAM **302**
- Upload code and data from flash memory of processor **292**, flash memory **308**, or any or all of the Port Controllers' flash memory.
- Upload code and data from NVRAM **302**
- Turn LCD +12V power on and off

- Turn Debug LED on and off
- Send commands and/or data to processor **296** (also known as the Main Controller)
- Get status and/or data from processor **296** (also known as the Main Controller)
- Submit any of the above to another control and monitoring system connected to communications port **12** via at least one daisy chain cable **440**.

Once the Host Controller receives one of the above commands it processes it and looks for more commands from the remote computer communicating through the communications port **12**.

Red, Green, Blue, Horizontal Sync, and Vertical Sync (RGBHV) Signals **326**, **328**, **330**, **332**, **334**, **336**, **338**, **340**, **342**, **344**, **346**, **348**, **350**, **352**, **354**, **356** are received by the video switch **324**. A video select signal **322** causes the video switch **324** to pass Red, Green, and Blue video signals **362** to a video driver **420**. The video select signal **322** also causes the video switch **324** to pass Horizontal and Vertical Sync signals to a Programmable Logic **364**.

The processor **370**, also known as the Host Controller, takes the local Horizontal Sync generated by Programmable Logic **364,** generates the local Vertical Sync and passes to the Programmable Logic **364.** The processor **296**, also known as the Main Controller passes data over the data path **366** for on screen menu display to the video driver **420**. Red, Green, and Blue video signals are overlaid with on screen menu display data, if any, and a set of amplified Red, Green, Blue, Horizontal Sync, and Vertical Sync video signals **422** are sent to video port **10**. A set of amplified Red, Green, Blue, Horizontal Sync, and Vertical Sync video signals **424** are sent to video port **54**.

The processor **296**, also known as the Main Controller also checks to see if Vertical Sync signal **358** and Horizontal Sync signal **360** are being provided by one of the remote computers through the video switch **324**. If there are no such signals, the Main Controller enables the local Vertical Sync and Horizontal Sync signals and passes Horizontal Sync and

Vertical Sync signals **367** and instructs programmable logic device **364** to pass said signals to the video driver **420**.

The processor **370** also communicates with other Host Controllers on other control and monitoring units via a daisy chain cable **440** connected to the communications port **12** of each control and monitoring unit.

The processor **296**, also known as the Main Controller controls and monitors eight processors **232, 234, 236, 238, 240, 242, 244, 246**. The Programmable Logic **298** provides the processor **296** with code for being able to communicate with the processor **370** and also the other eight processors **232**, **234**, **236**, **238**, **240**, **242**, **244**, **246**.

The Main Controller looks for and processes commands from the Host Controller. Commands coming from the Host Controller include but are not limited to:

- Get the current status
- Perform the following diagnostic tests:
  - Select video port 1-16 through the video switch
  - Enable and disable video port
  - Turn on and off Horizontal Sync and Vertical sync
  - Enable and disable video driver
  - Show graphics window while measuring the horizontal sync and vertical sync signals
- Download code and data and program the flash memory **308** or NVRAM **302**
- Upload code and data from flash memory **308** or NVRAM **302**
- Erase flash memory **308**
- Verify code in flash memory **308**
- Turn LCD +12V power on and off
- Turn Debug LED on and off
- Echo data back

The Main Controller also performs the following tasks as dictated by the program loaded from flash memory **308**:

- Presents the selected port number or system name associated with the port number on the display **68**

- As keyboard signals **316** and mouse signals **318** are received into processor **296**, the Main Controller detects such a condition and does the following:
  - Reads the keyboard and mouse data
  - Checks to see if the menu entry key has been typed. The menu entry key is a predetermined character sequence. For example, either the "Print Screen" or "Pause" keys could be used to trigger the on screen menu. Other keys to invoke the on screen menu may also be designated by a human user.
  - If the menu entry key has not been typed, the keyboard and mouse data is passed to the currently selected KVM port through the appropriate Port Controller.
  - If the menu entry key has been typed, the Main Controller performs the following:
    - Set currently selected port to DESELECTED to Port Controller
    - Present a Main menu on screen
    - Process the Main menu commands in the following manner until an exit or cancel command or a timeout is received:
      - Present the selected port number on screen
      - Look for a menu command
      - If an Exit command or a timeout is received then
        - Re-initialize the keyboard **72** and the touchpad **70** to the currently selected port states. For example, the state of the mouse scaling and resolution.
        - Re-initialize any keyboard attached to keyboard port **14** to the currently selected port states. For example, the state of "Num Lock" or "Caps Lock".
        - Re-initialize any pointing device attached to mouse port **16** to the currently selected port states.
      - Remove the menu from the screen and show the currently selected port's video.
      - If a Set Selected Port command is received then the user is allowed to select a port using the number keys, function keys, or cursor keys on the keyboard and then confirm the selection with the Enter key on the keyboard.
      - The state of the selected port is set to SELECTED and it

informs the associated Port Controller and the Exit command is processed as described above.

- If an About command is received then show company's current information, version, and copyright information and wait for Main menu or Exit commands. If the Main menu command is received then return to the Main menu. If the Exit command is received then process it as described above.
- If a Detail command is received then show information for the first eight KVM ports **20, 22, 24, 26, 28, 30, 32,** and **34**. Information includes the port number, name associated with the port, and whether the port is marked ACTIVE or INACTIVE. The menu code then waits for a command and processes it as follows:
  - If the Main menu command is received the Main menu is displayed.
  - If the Exit command or a timeout is received it is processed as described above.
  - If a Next command is received then show information for the next eight KVM ports **36, 38, 40, 42, 44, 46, 48,** and **50**. Information includes the port number, name associated with the port, and whether the port is marked ACTIVE or INACTIVE. Then menu code then waits for a command and processes it as follows:
    - If the Main menu command is received the Main menu is displayed.
    - If the Exit command is received it is processed as described above.
    - If a Previous command is received it is processed as the Detail command described above.
- If a Setup command is received then process commands in the following manner:
  - Disable timeout on waiting for input
  - Display the Setup menu
  - If an Exit command is received then process it as described above

    - If a Discard Setup command is received then return to the Main menu without saving any changes.
    - If an Edit Ports 1-8 command is received then display information about KVM ports **20, 22, 24, 26, 28, 30, 32,** and **34** and allow the user to type in a system name and description associated with the port using the arrow keys and character keys. If a Previous command is selected with the arrow keys or page up key then return to the Setup menu. If an Exit command is selected process it as described above.
    - If an Edit Ports F1-F8 command is received then display information about KVM ports **36, 38, 40, 42, 44, 46, 48,** and **50** and allow the user to type in a system name and description associated with the port using the arrow keys and character keys. If a Previous command is selected with the arrow keys or page up key then return to the Setup menu. If an Exit command is selected process it as described above.
  - If a Save Setup command is received then request the user to enter the password. If the password matches the currently saved password then update and save the settings to flash memory **308** and return to Main menu. If the password does not match then return to the Setup menu.
  - If a Change Password command is received then request the user to enter the currently saved password. If the password does not match then return to the Setup menu. If the password matches the saved password then allow the user to enter a new password twice. If the two new passwords match then save it to flash memory **308** and return to the Main menu. If the two new passwords do not match then repeat the Change Password process.
- Polls the Port Controller for the selected port for new changes in keyboard and mouse states and status.

    - If new keyboard states and status are available from the KVM port they are sent to the keyboard **72** and the external keyboard port **14**.
    - If new mouse states and status are available from the KVM port they are sent to the touchpad **70** and the external mouse port **16**.
- If no keyboard or mouse "connected" signals are detected from the KVM port for a specified period of time then the Port Controller will mark the port INACTIVE and return such status. Poll the Port Controller for ports marked as ACTIVE ports
    - If new states and status are available then update the states of the port and mark it as ACTIVE
    - If no keyboard or mouse "connected" signals are detected from the KVM port for a specified period of time then that port is marked INACTIVE
- Poll the Port Controller for ports marked as INACTIVE ports
    - If keyboard or mouse "connected" signals are detected from the KVM port for a specified period of time then mark the status for the port as ACTIVE
    - If no keyboard or mouse "connected" signals are detected from the KVM port for a specified period of time then keep the status for the port as INACTIVE

Any of the eight processors **232**, **234**, **236**, **238**, **240**, **242**, **244**, **246** are also known as a Port Controller.

Each Port Controller sends and receives keyboard and mouse data between the Main Controller and each of two KVM ports. Each Port Controller performs the following tasks in a loop:

- Check for keyboard or mouse data from the Main Controller
- If the keyboard or mouse data is for one of the two KVM ports connected to the Port Controller then send the keyboard and mouse data through the appropriate KVM port.
- Check for a request for status from the Main Controller
- If a request for status from the Main Controller is received then send the keyboard or mouse states and the status of either ACTIVE or INACTIVE for the KVM port to the Main Controller.
- Check for keyboard or mouse data from the KVM ports

- If there is keyboard or mouse data from the KVM ports then process it, save the state such as Num Lock, Caps Lock and send the appropriate responses back through the KVM ports. Such states are sent back to the keyboard or mouse on the next poll from the Main Controller.
- Poll to see if there is a computer that is asserting the keyboard and mouse "connected" signals going to each of the two KVM ports. If there is a connection within a specified period of time then mark the port as ACTIVE. If there is no connection within a specified period of time then mark the port as INACTIVE.

Multiple control and monitoring systems may be daisy chained together. The first control and monitoring system is designated as a Master System. Each additional control and monitoring system is referred to as a Slave System. A connector for communications port and daisy chain **444** of a daisy chain cable **440** plugs into the communications port **12** of the Master System. A connector for communications port and daisy chain **442** plugs into the communications port **12** of a Slave System. Additional slave systems are added by connecting a connector for communications port and daisy chain **444** of an additional daisy chain cable **440** into the connector for communications port and termination **448** of a Slave System at the end of the daisy chain and plugging the connector for communications port and daisy chain **442** of the communications cable **440** into the communications port **12** of the Slave System to be added. The first and last daisy chain cable in the daisy chain requires a terminator **610** on the communications port and termination connector **446** or **448**. A KVM Cable **100** also connects each Slave System to the Master System. The keyboard connector **106** is plugged into the external keyboard port **14** of a Slave System. The mouse connector **108** is plugged into the external mouse port **16** of the Slave System. The video connector **104** is plugged into the external video port **10** of the Slave System. The KVM connector **102** plugs into one of the KVM ports **20**, **22**, **24**, **26**, **28**, **30**, **32**, **34**, **36**, **38**, **40**, **42**, **44**, **46**, **48**, **50** of the Master System.

The Master System and Slave Systems communicate over the daisy chain cables **440** using the Serial Peripheral Interface (SPI) protocol as documented in "Microcontroller Data Book, AT86 Series" published December 1997 by Atmel Corporation. The MOSI signal called out in the data book is seen here as an RS-485 Tx signal pair (Tx+, Tx-). The MISO signal called out in the data book are seen here as the RS-485 Rx signal pair (Rx+,Rx-). The SCK signal called out in the data book is seen here as the RS-485 Clock signal pair (Clock+,Clock-).

The Master System uses the single-ended Transmit/Receive Data signal **398** to transmit data via EIA-RS-485 Transceiver **378**. The EIA-RS-485 Transceiver **378** transmits data to Slave Systems using the Differential Transmit/Receive Data High signal **392** and the Differential Transmit/Receive Data Low signal **396**.

A Slave System uses the single-ended Transmit/Receive Data signal **398** to receive data via EIA-RS-485 Transceiver **378**. The EIA-RS-485 Transceiver **378** receives data from the Master System using the Differential Transmit/Receive Data High signal **392** and the Differential Transmit/Receive Data Low signal **396**.

The Master System uses the single-ended Receive/Transmit Data signal **406** to receive data via EIA-RS-485 Transceiver **380**. The EIA-RS-485 Transceiver **380** receives data from Slave Systems using the Differential Receive/Transmit Data High signal **400** and the Differential Receive/Transmit Data Low signal **404**.

A Slave System uses the single-ended Receive/Transmit Data signal **406** to transmit data via EIA-RS-485 Transceiver **380**. The EIA-RS-485 Transceiver **380** transmits data to the Master System using the Differential Receive/Transmit Data High signal **400** and the Differential Receive/Transmit Data Low signal **404**.

The Master System uses the single-ended Clock signal **414** to transmit a clock signal to an EIA-RS-485 Transceiver **382**. The EIA-RS-485 Transceiver **382** transmits a differential clock signal to a Slave System using the Differential Clock High signal **408** and the Differential Clock Low signal **412**.

A Slave System receives a single-ended clock signal from the EIA-RS-485 Transceiver **382** through the Clock signal **414**. The EIA-RS-485

Transceiver **382** receives a differential clock signal from the Master System through the Differential Clock High signal **408** and the Differential Clock Low signal **412**.

The Master System and Slave Systems communicate with each other through cascade signals using the SPI protocol. The Master System is always in control and through one of its KVM ports **20**, **22**, **24**, **26**, **28**, **30**, **32**, **34**, **36**, **38**, **40**, **42**, **44**, **46**, **48**, **50** it can display the video from a Slave System port **10** and control the keyboard port **14** and mouse port **16** of the Slave System. Switching KVM ports in the Master System is equivalent to switching groups of computers, each group of computers being attached to a Slave System. The control menu in the Master System allows the switching and selection of one of the KVM ports **20**, **22**, **24**, **26**, **28**, **30**, **32**, **34**, **36**, **38**, **40**, **42**, **44**, **46**, **48**, **50**, each of which could represent KVM ports **20**, **22**, **24**, **26**, **28**, **30**, **32**, **34**, **36**, **38**, **40**, **42**, **44**, **46**, **48**, **50** on a Slave System or a combination of groups of computers and individual computers. Once a group is selected the Master System can use cascade signals to command the group associated with the Slave System to display its port selection and allow a specific KVM port on the Slave System to be connected. The process described saves an additional step of having to first select a KVM port on the Master System and then select a KVM port on the Slave System. The use of cascade signals also provides a way to transfer configuration and operational state information from Slave Systems to the Master System for improved user interface and quick access to each KVM port's status information. Thus, the combination of Master Systems and Slave Systems appear to function as one large control and monitoring system.

Additional Embodiments

An additional embodiment is one where the control and monitoring system may be mounted vertically on the side of a rack instead of being mounted horizontally in the rear of a rack.

Another embodiment utilizes the keyboard-video-mouse switch and a plurality of keyboard-video-mouse cables without the keyboard, pointing device, and video display. Such an embodiment would allow connection to other keyboard-video-mouse switches in a tiered fashion whereby a video

display output port of a first keyboard-video-mouse switch is connected to a video display input port of a second keyboard-video-mouse switch, a keyboard input port of the first keyboard-video-mouse switch is connected to a keyboard output port of the second keyboard-video-mouse switch, and a mouse input port of the first keyboard-video-mouse switch is connected to a mouse output port of the second keyboard-video-mouse switch. In addition the cascade signals between the Systems would improve the user interface of the controlling Master system with the video display, keyboard and mouse devices.

Alternative Embodiments

An alternative embodiment comprises processor equivalents such as Central Processing Units (CPUs) instead of processors.

There are various possibilities with regard to the pointing device and video display. The pointing device could be a trackball, graphics tablet, joystick, or mouse. The video display and pointing device could be combined into a touchscreen device.

Another alternative embodiment comprises a KVM switch capable of being daisy chained such that a plurality of interconnected KVM switches appears to be a single switch with more ports than a single KVM switch to a human user.

Advantages

From the description above, a number of advantages of the control and monitoring system become evident:

Rack space required for video display, character input, and pointing device is kept to a minimum.

The number of separate connectors required to connect a system to a KVM switch is reduced from three (3) to one (1), reducing the likelihood of a failure due to a loose connection caused by stress on an individual cable.

The video display, character input device, and pointing device of the control and monitoring system may extend out of a rack as a single unit. Traditional solutions to control and monitor multiple computer

systems require a human user to extend a keyboard drawer. The video display in such solutions had to be extended separately or mounted flush with the rack and consuming valuable vertical rack space. Alternatively, a video display attached to a keyboard drawer by a hinge could be extended out of a rack with a keyboard and pointing device but consumed 2U (3.50 inches) of vertical rack space.

An external control port on the opposite side allows a second video display, character input device, and pointing device to be connected to the control and monitoring system. This is useful in a trade show environment where a computer video display output may be sent to a video projection system or line driver and a remote control device may be used to control character input or pointing input or both character input and pointing input.

A plurality of control and monitoring systems may be daisy chained together in a tiered fashion whereby a human user may access multiple control and monitoring systems as well as the systems connected to the control and monitoring systems from a single control and monitoring system. Traditional KVM switches may be daisy chained but the number of KVM switches that may be connected is limited.

The control and monitoring system may switch off power to the video display after a period of time has elapsed, reducing power consumption and thermal emissions when the control and monitoring system has not been utilized for a specified period of time.

A minimum of one processing unit for every two ports on the control and monitoring system allows the control and monitoring system to sample each computer connected to the control and monitoring system for video display independent of the other ports on the control and monitoring system, reducing the likelihood of losing data at a critical time. Another processor reduces the likelihood of losing character input or pointing input to the control and monitoring system from a human user by independently sampling for character input and pointing input.

The video display, character input device, and pointing device are protected from dust and impact from objects when the control and monitoring system is in the closed position.

No special software or hardware is required to be installed on the computer that is being controlled, other than a cable which has a single

connector on one end and connectors for video display, character input, and pointing input on the other end.

CONCLUSION, RAMIFICATIONS, AND SCOPE OF INVENTION

Accordingly, the reader will see that the control and monitoring system of this invention allows a user to apply input to and view the video display output of multiple computer systems. Loss of data is prevented by utilizing multiple processors to handle keyboard and mouse signals and to pass video signals through a video switch. The control and monitoring system may be restarted by a remote operator or have its programming downloaded or uploaded to a remote computer system, easing the job of troubleshooting and maintenance of upgrades. The control and monitoring system consumes a minimum of space by removing the need for separate mini-DIN connectors for keyboard and mouse signals on the control and monitoring system side and using a single fifteen position D-sub connection for keyboard, mouse, and video display signals. Furthermore, the control and monitoring system has the additional advantages of:

(a) allowing more than the eight (8) systems currently allowed by current keyboard-video-mouse (KVM) switches while consuming the same amount of vertical rack space as a conventional KVM switch;

(b) providing a video display, a character input device, and a pointing device which consumes a minimum of vertical rack space;

(c) allowing connection to other control and monitoring systems in a tiered fashion so more than sixteen (16) systems may be controlled and monitored.

Although the description above contains many specificities, these should not be construed as limiting the scope of the invention but as merely providing illustrations of some of the presently preferred embodiments of this invention. For example, the control and monitoring system can use more processors; more than sixteen (16) ports could be used; a different pointing device could be used, etc. Thus the scope of the invention should be determined by the appended claims and their legal equivalents, rather than by the examples given.